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Toward shared understandings of ecosystem-based fisheries management among fishery management councils and stakeholders in the U.S. Mid-Atlantic and New England regions

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ABSTRACT

Ecosystem-based fisheries management (EBFM) is often discussed by fisheries managers and stakeholders as a potential goal. EBFM is based on a multi-species approach, which varies significantly from the single species fisheries management (SSFM) approach currently practiced under the U.S. Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). EBFM is "holistic" and considers "all factors," but it is impossible for management to incorporate all factors into EBFM. This study sought to improve understanding of factors contributing to or preventing progress toward EBFM implementation in the Mid-Atlantic Fishery Management Council (MAFMC) and New England Fishery Management Council (NEFMC), focusing on Council member and stakeholder beliefs, attitudes, and mutual understanding. Objectives included determining mutual understanding between MAFMC and NEFMC members and stakeholders about EBFM and identifying MAFMC and NEFMC member and stakeholder preferences for EBFM definitions, practices, and outcomes, and prioritizing which aspects of EBFM managers and stakeholders find most important. Stakeholders included commercial fishermen, recreational anglers, nongovernmental organization (NGO) leaders, and Scientific and Statistical Committee (SSC) members. Over 1000 survey responses about EBFM from council members and stakeholders in the Mid-Atlantic (MA) and New England (NE) regions were analyzed. The *Coorientation Model* was used to characterize understanding between the Council and fisheries-related stakeholder groups. For the MA and NE regions, most stakeholders agreed on definitions, practices, and possible outcomes for EBFM. Results suggest that most Council members and stakeholders in the MA and NE regions support a change from SSFM to EBFM at an incremental, intermediate, or complete, gradual (5–10 years) pace. The application of the *Coorientation Model* to EBFM and the fishery management councils provided insights into how an improved understanding of the attitudes, beliefs, and mutual comprehension of Council members and stakeholder groups could potentially facilitate the implementation of EBFM. Council members and stakeholders responded similarly to, and Council members correctly predicted stakeholder responses about, EBFM definitions, practices, and outcomes. These findings suggest that Council member and stakeholder agreement and understanding are not barriers to MAFMC and NEFMC adoption of EBFM.

1. Introduction

Ecosystem-based fisheries management (EBFM), a component of the broader concept of ecosystem-based management, a holistic approach to wildlife and fisheries management [1], is discussed often by fisheries stakeholders, including fisheries managers and fishermen. EBFM is defined as the process of "managing fisheries to coordinate, account for, and include all factors in a holistic, synthetic, integrated fashion" [2]. A distinguishing feature of EBFM is that it is based on a multi-species approach, which varies significantly from the single species fisheries management (SSFM) approach currently practiced under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) [3], one of the guiding pieces of legislation for fisheries policy in the federal United States' (U.S.) Exclusive Economic Zone. Although the anticipated 2014 reauthorization of MSFCMA has not yet occurred, a reauthorization could more explicitly mandate the use of EBFM.

The Fishery Conservation and Management Act (FCMA) [3], a precursor to the MSFCMA enacted in 1976, designated the creation

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of eight regional fishery management councils within the U.S. Within their respective regions, the FCMA/MSFCMA granted councils the authority to identify which fisheries require management and to develop fisheries management plans, amendments, and suggested regulations to manage the selected fisheries [1]. In practice, all eight regional councils have followed an institutional precedent to practice SSFM under the MSFCMA, although all are currently carrying out some level of EBFM planning or implementation [4]. Considerable analysis has been done to determine if and how EBFM is being incorporated into regional fishery management council policies [5]. However, with the prospect of change from SSFM to EBFM underway or anticipated in multiple councils, understanding how key players conceive of EBFM is critical to fostering shared understanding. This study was initiated to identify important factors in whether or not two different U.S. fisheries management councils would move forward with EBFM, providing tangible information for those two and other regional U.S. fishery management councils to use when making management decisions about the future of EBFM.

The *Coorientation Model* [6–8] and mail survey data were used to characterize beliefs, attitudes, and mutual understanding about EBFM in the Mid-Atlantic (MA) and New England (NE) regions, including the extent of agreement among Council members and stakeholders, and the ability of Council members to predict stakeholder responses (Fig. 1). Survey topics also included perceptions about the definition of EBFM, fisheries management practices that should be implemented over the next 10 years, and desired outcomes for fisheries management in each region.

"Council members" refers to either Mid-Atlantic Fishery Management Council (MAFMC) or New England Fishery Management Council (NEFMC) members and "stakeholders" refers to commercial fishermen, recreational anglers, nongovernmental organization (NGO) leaders, and Scientific and Statistical Committee (SSC) members. Disaggregated stakeholder data were analyzed to distinguish among groups. The MA region includes New York, New Jersey, Pennsylvania, Maryland, Delaware, Virginia, and North Carolina. The NE region includes Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. *Agreement* was defined as "the extent to which Council members and stakeholders hold the same attitudes and beliefs" and *accuracy* was defined as "the extent to which Council members' predictions of stakeholder attitudes and beliefs is similar to the stakeholders' actual attitudes and beliefs" [8]. Coorientation measures characterized the similarity of Council member and stakeholder attitudes about EBFM and how well Council members predicted, or perceived, stakeholder attitudes about EBFM. The study has several objectives including determining mutual understanding between MAFMC and NEFMC members and stakeholders about EBFM and identifying MAFMC and NEFMC member and stakeholder preferences for EBFM definitions, practices, and outcomes. Because EBFM is "holistic" and considers "all factors," but it is impossible for management to incorporate all factors into EBFM, this study will help prioritize which aspects of EBFM managers and stakeholders find most important.

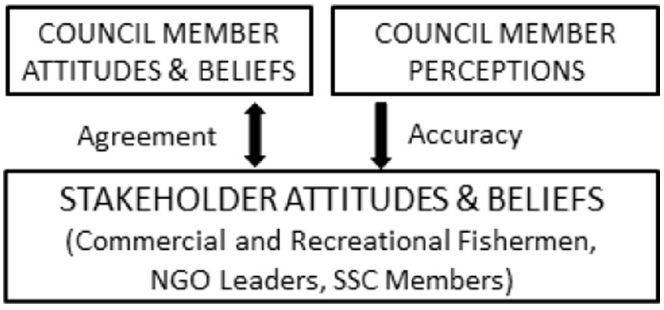

Fig. 1. Coorientation model used in the study, adapted from previous work [6,7].

2. Methods

2.1. Mail survey methodology

A mail survey was used to measure perceptions and to characterize understanding about EBFM between Council members and stakeholders in the MA and NE regions using the *Coorientation Model* [7,8]. Using the Coorientation Model, pairwise contrasts were made between decision makers and *subsets* of the class "stakeholder." Two versions of the mail survey were developed, a *decision maker* survey and a *stakeholder* survey. The decision maker survey was sent to Council members, Council Staff members, and SSC members from the MA and NE regions. SSC member responses are reported here as stakeholder responses. The stakeholder survey was sent to registered commercial fishermen, registered or permit-holding recreational anglers, priority recreational anglers on Council communication lists, and leaders of NGOs with interests in federal fisheries in the MA and NE regions. Results are not reported here for Council staff members or priority recreational anglers. 5651 surveys were distributed through four mailings between January 16, 2013 and March 1, 2013 in the MA and NE regions to selected individuals in decision maker and stakeholder groups, according to the methods of Dillman [9].

2.2. Identification of survey recipients

MAFMC, NEFMC, and SSC member contact information was compiled from the MAFMC [10] and NEFMC [11] websites. The lists of commercial fishermen and recreational anglers were created by randomly selecting a subsample of individual names from the list of permit holders for each group from both the MA and NE regions. A publicly accessible government-supported database [12] was consulted, which contained the contact information of individuals listed as holders of NOAA Fisheries Northeast Region Vessel Operator cards (permits) on the National Oceanic and Atmospheric Administration's website (as of 7/9/12) [12], to identify the sample of survey recipients from the commercial fishing industry in the MA and NE regions. Marine recreational permitting lists are controlled by state governments, and permitting information was released on a state-by-state basis. Marine recreational fishermen were randomly sampled from each of the four 2011–2012 state registries of registered marine recreational anglers that were provided by states, two states from the MA region (Pennsylvania and one state that requested anonymity) and two from the NE region (Connecticut and Massachusetts). Registrants under the age of eighteen were removed from data sets before sampling. To compile the NGO leader stakeholder list for marine fisheries organizations in the MA and NE regions, an internet search was conducted for the phrases "nongovernmental organizations in Mid-Atlantic fisheries" and "nongovernmental organizations in New England fisheries" and the contact information for either the leaders of relevant organizations, or the people who were most directly related to marine fisheries for the organizations, was included in the sample. Additionally, the observation notes and sign-in sheets and contact lists from Council staff and MAFMC and NEFMC full meetings from 2011 and 2012 were reviewed to identify representatives from nongovernmental marine fisheries-related organizations.

2.3. Non-respondent phone follow-up

A non-respondent telephone survey follow-up was conducted through the Survey Research Institute at Cornell University. The

non-respondent phone follow-up consisted of a shortened version of the mail survey conducted by telephone, from March 28, 2013 through April 16, 2013, with 200 survey non-respondents (50 MA commercial fishermen, 50 MA recreational anglers, 50 NE commercial fishermen, and 50 NE recreational anglers) [13,14]. Council members and NGO leaders were not included in the non-respondent phone follow-up because these group sizes were small initially.

2.4. Chi-square test for association

To analyze the results from the non-respondent phone follow-ups, a *Chi-square test for association* (*Pearson Chi-Square* was used since neither variable was dichotomous) in SPSS [15] was used to compare the survey responses between the initial survey response group and the non-response group to determine if survey group was statistically independent of survey response at the $p < 0.05$ level. *Cramer's V* was used since neither variable is dichotomous.

2.5. Survey data analyses

Data from the returned questionnaires were entered into a computerized data file and SPSS [15] was used for analysis. A *Two-Way Analysis of Variance* and a post-hoc *Tukey* test, assuming equal variances, were used to analyze the survey response data. Standard assumptions [16] were checked and found reasonable and consistent throughout the analysis. To determine if there were statistically significant differences in mean survey responses between stakeholder groups, a Bonferroni adjustment was made to the Two-Way ANOVA for multiple comparisons. To calculate *agreement level* and *accuracy level* between Council members and each of the relevant stakeholder groups from the appropriate region, mean survey responses for each stakeholder group to each question and Council member mean predictions of each stakeholder group's responses to each question were calculated. Survey respondents had the choice to select 1, 2, 3, 4, 5, or "Don't Know." All survey responses were measured on a Likert scale of 1-5 ("Don't Know" responses were removed from the data set for analysis). The absolute values of the differences in mean response between Council members and each of the stakeholder groups (*agreement*) and the absolute values of the differences in mean predictions of Council members for each stakeholder group and the mean responses of each stakeholder group (*accuracy*) were calculated. The maximum possible difference in mean response was 4, representing the lowest possible agreement or accuracy. The minimum difference in mean response was 0, representing complete agreement or accuracy. To represent *agreement level* and *accuracy level* as directly correlated to agreement and accuracy, *agreement level* and *accuracy level* were calculated by subtracting the absolute value of the mean response difference from 4. Therefore, 4=highest *agreement level* and *accuracy level* and 0=lowest *agreement level* and *accuracy level* where *AGREEMENT LEVEL* or *ACCURACY LEVEL*={*4-(Absolute value of mean response difference)*}.

3. Results and discussion

3.1. Survey response rates

Of 5651 surveys mailed, 1083 were returned; response rate varied by group from 57% to 14% (Table 1). Survey response rates were higher for the groups contacted or interviewed by phone or in person before receiving the survey. For example, the response rate for MA_MEM (MAFMC members) and NE_MEM (NEFMC members) were the highest, and almost every member in each of these groups had initially been contacted. Some of the MAFMC and the NEFMC staff members and SSC members, groups which also had fairly high response rates, were interviewed individually. The MA_CF, NE_CF, MA_RA, and NE_RA survey recipient groups, which had the lowest response rates, were randomly selected. The members of the MA_NGO and NE_NGO groups were selected by identifying all known environmental nongovernmental organizations with interests in EBFM in the Mid-Atlantic and New England as well as groups who signed the Council meeting sign-up sheets. Some of the NGO groups that received the survey would have been aware of the research project from attending Council meetings, which may have been reflected in those groups' higher survey response rates.

Table 1
Survey response rates to decision maker and stakeholder surveys distributed to recipients in the MA and NE regions. Abbreviations: MA_MEM or NE_MEM=MA or NE Council members; MA_STAFF or NE_STAFF=MA or NE Council Staff members; MA_SSC or NE_SSC=MA or NE Scientific and Statistical Committee members; MA_CF or NE_CF=MA or NE commercial fishermen; MA_RA or NE_RA = MA or NE recreational anglers; MA_NGO or NE_NGO = MA or NE nongovernmental organization leaders. Five individuals submitted surveys for both the MA_MEM and NE_MEM groups given their dual roles.

Survey recipient group (MA=Mid-Atlantic; NE=New England)	# Returnd	# Sent	% Response rate
MA_MEM	21	30	70%
NE_MEM	14	23	61%
MA_STAFF	7	12	58%
NE_STAFF	6	19	32%
MA_SSC	7	19	37%
NE_SSC	7	15	47%
MA_CF	279	1333	21%
NE_CF	238	1333	18%
MA_RA	232	1333	17%
NE_RA	190	1333	14%
MA_NGO	16	56	29%
NE_NGO	39	78	50%
SUM	**1056**	**5584**	**18.91%**

3.2. Chi-square test for association to assess non-response bias

For the *Chi-square test for association* between survey set and familiarity with EBFM, all expected cell frequencies were greater than 5. There was a statistically significant (χ^2 (3)=19.659, p=0.000), but small association (φ=0.133, p=0.000) between survey set and familiarity with EBFM. For the *Chi-square test for association* between survey set and familiarity with *"Mid-Atlantic Fishery Management Council"* and *"New England Fishery Management Council,"* all expected cell frequencies were greater than 5. There was a statistically significant (χ^2 (3)=12.771, p=0.005), but small association (φ=0.107, p=0.005) between survey set and familiarity with the term *"Mid-Atlantic Fishery Management Council"* or *"New England Fishery Management Council."* [17] Based on these analyses, no corrections were made to the data to adjust for non-response bias.

A phone survey was conducted with non-respondents to the mail survey to determine if there were characteristics unique to the group of people who received the survey and did not respond compared to the group of people who received the survey and did respond. The purpose of the *Chi-square tests for association* was to determine if the survey respondents and non-respondents represented similar populations and whether there was self-imposed non-participation of a certain survey response group that could have biased survey results. Since there was a significant but only small association between survey respondents and non-respondents and familiarity with EBFM or the Councils, it was determined that any bias between the survey takers and non-takers related to familiarity with EBFM or the Councils was negligible.

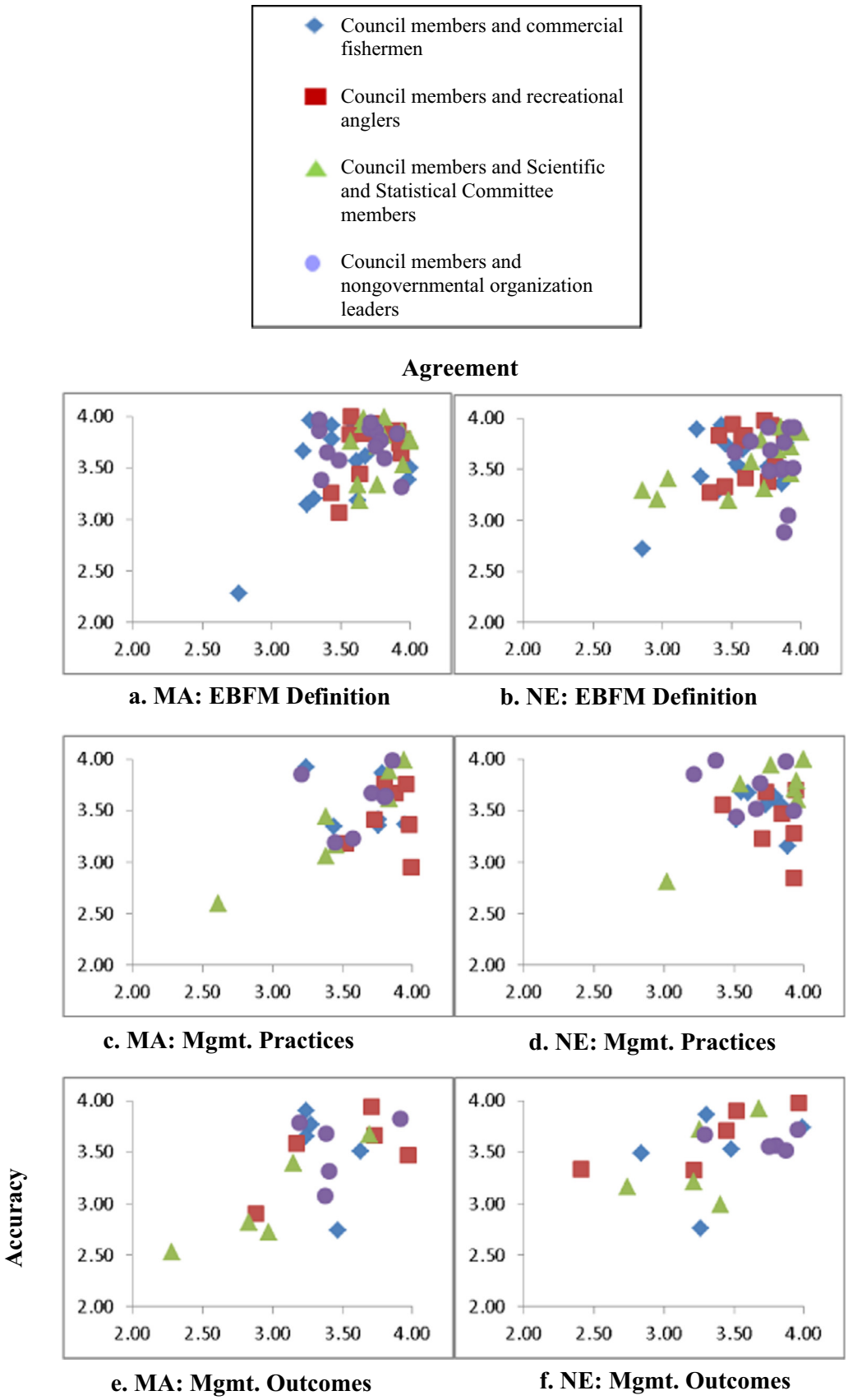

Fig. 2. a-f Agreement and accuracy for MA and NE Council members compared to each of four stakeholder groups. X-axes are AGREEMENT LEVEL (0=lowest agreement; 4=highest agreement). Y-axes are ACCURACY LEVEL (0=lowest accuracy; 4=highest accuracy). a and b show MA and NE survey responses regarding the definition of EBFM. c and d show MA and NE survey responses regarding fisheries management practices. e and f show MA and NE survey responses regarding fisheries management outcomes.

3.3. Survey responses: agreement levels and accuracy levels

Agreement levels and *accuracy levels* for responses to the survey questions about definitions, practices, and outcomes for EBFM are described below (Fig. 2a-f). Responses from different survey response groups were often contained within a narrow range of answer choices because the survey design was based on information gained from pre-survey interviews with Council members and stakeholders, reflecting real-life opinions of people in the survey response groups.

3.3.1. Defining EBFM: agreement and accuracy

3.3.1.1. Agreement. *Agreement levels* were relatively high for both MA (Fig. 2a) and NE (Fig. 2b) Council member and stakeholder responses for the question: *Please indicate to what extent YOU agree or disagree that the definition of "ecosystem-based fisheries management" should include the following concepts?* Paired Council member and stakeholder mean responses to the question were generally at an *agreement level* of 3.0 or higher (Fig. 2a and b). Council members and stakeholders in both the MA and NE regions generally responded identically or similarly to the question about what concepts to include in the definition of EBFM. MA and NE Council members and stakeholders responded either *Strongly agree, Agree*, or *Neutral* to whether the definition of EBFM should include the concepts listed in the survey (Table 2). These results suggest that Council members and stakeholders often have the same or similar perspectives about factors that should be included in the definition of EBFM.

Out of the 13 concepts listed as potential concepts to be included in the definition of EBFM, MA and NE stakeholders and Council members responded *Neutral* to only 2 concepts and *Strongly agreed* or *Agreed* that the definition of EBFM should include all 11 of the other concepts (Table 2). MA commercial fishermen, NE commercial fishermen, and NE recreational anglers responded *Neutral* to *Developing stakeholder buy-in* as part of the definition of EBFM. Also, MA commercial fishermen, MA recreational anglers, MA NGO leaders, and NE Council members responded *Neutral* to *Balancing diverse social objectives* in the definition of EBFM. These results suggest that stakeholder buy-in and diverse social objectives were not priorities for some stakeholders. All MA and NE survey respondents answered *Agree* and MA SSC members answered *Strongly agree* that *Accounting for uncertainty in ecosystems* should be included in the definition of EBFM.

Agreement level was less than 3 and responses were different between Council members and stakeholders for some concepts and pairs. For *Developing stakeholder buy-in*, MA Council members responded *Agree* and MA commercial fishermen responded *Neutral* (*agreement level*=2.77) and NE Council members responded *Agree* and NE commercial fishermen responded *Neutral* (*agreement level*=2.86). For *Monitoring and enforcing EBFM*, NE Council members responded *Agree* and NE SSC members responded *Strongly agree* (*agreement level*=2.97). For *Balancing diverse social objectives*, NE Council members responded *Neutral* and NE SSC members responded *Agree* (*agreement level*=2.86).

3.3.1.2. Accuracy. *Accuracy levels* were relatively high for both MA (Fig. 2a) and NE (Fig. 2b) Council member responses for the question: *Please indicate to what extent YOU think fishers, environmental nongovernmental organization leaders, and Scientific and Statistical Committee members in the Mid-Atlantic/New England Region would agree or disagree that the definition of "ecosystem-based fisheries management" should include the following concepts.* Council members generally predicted stakeholder responses to the question with an *accuracy level* of 3.0 or higher, suggesting that

Table 2
Mean responses (with Standard Error) to the survey question "Please indicate to what extent YOU agree or disagree that the definition of ecosystem-based fisheries management (EBFM) should include the following concepts? " for Council members and stakeholder groups in the MA and NE regions. Abbreviations: PRED_CF or RA or SSC or NGO=Council members' prediction of perspectives from commercial fishermen, recreational anglers, SSC members and NGO leaders, respectively.

Variable	Region	MEM	CF	RA	SSC	NGO	PRED_CF	PRED_RA	PRED_ SSC	PRED_NGO
Considering the interactions between the physical, biological, and human factors that affect the health of fisheries.	MA	1.24[a] (.20)	2.01[a] (.06)	1.68 (.06)	1.00 (.35)	1.53 (.24)	1.67 (.22)	1.50 (.22)	1.67 (0.22)	1.65 (0.22)
	NE	1.36 (.25)	1.90 (.07)	1.62 (.07)	1.00 (.38)	1.21 (.15)	1.64 (.25)	1.64 (.25)	1.43 (.25)	1.71 (.25)
Protecting and/or enhancing habitat.	MA	1.38 (.20)	1.94 (.06)	1.51 (.06)	1.57 (.35)	1.57 (.25)	2.17 (.22)	1.67 (.22)	1.56 (.22)	1.17 (.22)
	NE	1.50 (.25)	1.95 (.06)	1.60 (.07)	1.67 (.38)	1.63 (.15)	2.43 (.25)	1.71 (.25)	1.36 (.25)	1.14 (.25)
Monitoring and enforcing EBFM.	MA	2.00 (.21)	2.43 (.06)	1.91 (.07)	1.57 (.35)	1.93 (.24)	2.56 (.23)	2.06 (.23)	1.81 (.23)	1.25 (.23)
	NE	2.23 (.26)	2.34 (.07)	1.83 (.08)	1.20 (.41)	1.75 (.15)	2.58 (.27)	2.42 (.27)	2.00 (.27)	1.42 (.27)
Assessing the social, economic, and cultural impacts on industries and communities that depend on fisheries.	MA	1.80 (.21)	1.78 (.06)	1.86 (.06)	1.86 (.35)	2.40 (.24)	1.17 (.22)	1.50 (.22)	2.00 (.22)	2.06 (.22)
	NE	2.29 (.25)	1.87 (.06)	1.80 (.07)	1.33 (.38)	2.05 (.15)	1.57 (.25)	1.86 (.25)	1.93 (.25)	2.57 (.25)
Developing stakeholder buy-in.	MA	1.95 [a] (.20)	3.19[ab] (.06)	2.47[c] (.07)	1.57 (.35)	2.20 (.24)	1.47[b] (.22)	1.53[c] (.22)	2.24 (.22)	2.06 (.23)
	NE	1.93[a] (.25)	3.07[ab] (.07)	2.59 (.08)	1.67 (.38)	2.16 (.15)	1.79[b] (.25)	1.85 (.25)	2.21 (.250)	2.07 (.25)
Adapting to changing biological and social conditions.	MA	1.62[a] (.20)	2.36[ab] (.06)	1.95 (.06)	1.43 (.35)	2.13 (.24)	1.50[b] (.22)	1.78 (.22)	1.61 (.22)	1.71 (.22)
	NE	1.57 (.25)	2.29 (.07)	2.00 (.08)	1.50 (.38)	1.51 (.15)	1.71 (.25)	1.79 (.25)	1.79 (.25)	2.00 (.25)
Incorporating geographically-specific management needs.	MA	1.71 (.20)	2.10 (.06)	1.81 (.06)	1.71 (.35)	2.00 (.24)	1.67 (.22)	1.67 (.22)	1.94 (.23)	1.94 (.23)
	NE	1.69 (.26)	2.16 (.07)	1.81 (.08)	1.67 (.38)	1.47 (.15)	1.71 (.25)	2.00 (.25)	1.79 (.25)	1.79 (.25)
Including flexibility into management strategies.	MA	1.81 (.20)	1.81 (.06)	1.86 (.06)	2.14 (.35)	2.47 (.24)	1.30 (.21)	1.63 (.21)	2.17 (.22)	2.33 (.22)
	NE	1.86 (.25)	2.00 (.06)	2.05 (.07)	1.33 (.38)	1.74[a] (.15)	1.36 (.25)	1.57 (.25)	2.14 (.25)	2.86[a] (.25)
Considering many ecological factors.	MA	1.52 (.20)	2.09 (.06)	1.81 (.06)	1.29 (.35)	1.43 (.25)	2.00 (.21)	1.74 (.21)	1.58 (.21)	1.26 (.21)
	NE	1.43 (.25)	2.00 (.07)	1.83 (.07)	1.50 (.38)	1.34 (.15)	1.93 (.25)	2.00 (.25)	1.29 (.25)	1.43 (.25)
Balancing diverse social objectives.	MA	2.14 (.20)	2.52[a] (.06)	2.51 (.06)	2.14 (.35)	2.79 (.25)	1.70[a] (.21)	1.95 (.21)	2.39 (.22)	2.17 (.22)
	NE	2.64 (.25)	2.41 (.07)	2.41 (.07)	1.50 (.38)	2.28 (.15)	1.79 (.25)	1.79 (.25)	2.21 (.25)	2.50 (.25)
Engaging stakeholders.	MA	1.65 (.21)	2.35[a] (.06)	2.22 (.07)	1.29 (.35)	1.87 (.24)	1.55[a] (.21)	1.47 (.21)	2.11 (.21)	1.63 (.21)
	NE	1.69 (.26)	2.30 (.07)	2.24 (.08)	1.83 (.38)	1.81 (.15)	1.57 (.25)	1.57 (.25)	1.93 (.25)	1.57 (.25)
Accounting for uncertainty in ecosystems.	MA	1.62 (.20)	2.34 (.06)	2.05 (.07)	1.29 (.35)	1.87 (.24)	2.30 (.21)	2.05 (.21)	1.37 (.21)	1.58 (.21)
	NE	1.50 (.25)	2.25 (.07)	2.09 (.08)	1.50 (.38)	1.55 (.15)	2.14 (.25)	1.93 (.25)	1.36 (.25)	1.64 (.25)
Addressing human needs, including those of fishermen and fishing communities.	MA	1.81 (.20)	1.49 (.06)	1.73 (.06)	1.86 (.35)	2.47 (.24)	1.10 (.21)	1.47 (.21)	2.33 (.22)	2.50 (.22)
	NE	1.93 (.25)	1.70 (.06)	1.71 (.07)	1.67 (.38)	1.84 (.15)	1.21 (.25)	1.79 (.25)	2.36 (.25)	2.79 (.25)

Agreement was measured on a 5-point scale where 1=Strongly agree, 2=Agree, 3=Neutral, 4=Disagree, and 5=Strongly disagree. Variable descriptions are identical to those printed in the survey.
[a,b,c]Statistically significant difference between groups with same letters within a row using a Bonferroni adjustment to the Two-Way ANOVA at $p \leq 0.05$.

Council members in both the MA and NE regions correctly predicted or closely predicted stakeholder responses about what concepts to include in the definition of EBFM. These results suggest that Council members often are aware of the preferences of stakeholders regarding the definition of EBFM.

There were exceptions to these general trends, in which *accuracy levels* were less than 3 and responses varied between Council member predictions and stakeholder responses regarding concepts to include in the definition of EBFM. For *Developing stakeholder buy-in*, MA Council members predicted MA commercial fishermen would respond *Strongly Agree* whereas the commercial fishermen actually responded *Neutral* (*accuracy level*=2.28) and NE Council members predicted commercial fishermen would respond *Agree* whereas the NE commercial fishermen actually responded *Neutral* (*accuracy level*=2.72). For *Including flexibility into management strategies*, NE Council members predicted NE NGO leaders would respond *Neutral* but the NGO leaders actually responded *Agree* (*accuracy level*=2.88).

3.3.2. Management practices: agreement and accuracy

3.3.2.1. Agreement. *Agreement levels* were relatively high between both MA (Fig. 2c) and NE (Fig. 2d) Council member and stakeholder responses for the question: *How important do YOU think it is that the following practices should be implemented as part of fisheries management in the Mid-Atlantic/New England Fishery Management Council (MAFMC/NEFMC) over the next 10 years?* Paired Council member and stakeholder mean responses to the question were usually at an *agreement level* of 3.0 or higher (Fig. 2c and d). Council members and stakeholders in both the MA and NE regions generally responded identically or similarly to the question about what practices should be implemented as part of fisheries management in the MAFMC and NEFMC over the next 10 years.

The most common difference in responses between members of a pair for this question was between *Very important* and *Moderately important*. With 2 exceptions, MA and NE council members and stakeholders responded that it was *Very important* or *Moderately important* that all of the EBFM practices listed in the survey be implemented as part of fisheries management in the MAFMC/NEFMC over the next 10 years (Table 3). Overall, MA and NE Council members and stakeholders both generally support EBFM practices listed in the survey being implemented as part of fisheries management in the MAFMC/NEFMC over the next 10 years. Currently, both the MAFMC and the NEFMC are moving forward, to some extent, with developing and/or implementing EBFM plans. All MA and NE survey recipients answered it was *Very important* to include *Continuing inclusion of stakeholders on the MAFMC/NEFMC Advisory Panel for EBFM* as a part of fisheries management (Table 3). Additionally, all MA and NE survey recipients *Agree* that *Engaging stakeholders* should be included in the definition of EBFM (Table 2). Both of these results demonstrate that inclusion of stakeholders in the management process, either in a specific role, such as Advisory Panel members, or more broadly, outlined by the phrase, *Engaging stakeholders,* is important to MA and NE Council decision makers and stakeholders. However, this support contrasts with the *Neutral* response from several stakeholder groups for including *Developing Stakeholder Buy-in* in the definition of EBFM (Table 2). *Agreement level* was below 3 for *Transitioning from management based on quotas set per individual species to management based on quotas set for the total biomass of all fish species caught*. For this practice, MA Council members responded *Very important* and MA SSC members responded *Slightly important* (*agreement level*=2.61).

3.3.2.2. Accuracy. *Accuracy levels* were relatively high for both MA (Fig. 2c) and NE (Fig. 2d) Council member responses to the question: *How important do YOU think fishers, environmental non-governmental organization leaders, and Scientific and Statistical Committee members in the Mid-Atlantic/New England Region think it is that the following practices should be implemented as part of fisheries management in the Mid-Atlantic/New England Fishery Management Council (MAFMC/NEFMC) over the next 10 years?* Council members generally predicted stakeholder responses to the question with an *Accuracy level* of 3.0 or higher, suggesting that Council members in both the MA and NE regions usually correctly predicted or closely predicted stakeholder responses about what practices should be implemented as part of fisheries management in the MAFMC/NEFMC over the next 10 years.

Table 3
Mean responses (with Standard Error) to the survey question "How important do YOU think it is that the following practices should be implemented as part of fisheries management in the Mid-Atlantic/New England Fishery Management Council (MAFMC/NEFMC) over the next 10 years? " for Council members and stakeholder groups in the MA and NE regions.

Variable	Region	MEM	CF	RA	SSC	NGO	PRED_CF	PRED_RA	PRED_ SSC	PRED_NGO
Identifying and prioritizing the key biological, physical, social, and economic factors that should drive decisions.	MA	1.77 (.24)	1.96 (.07)	1.90 (.08)	1.83 (.46)	2.07 (.29)	2.26 (.26)	2.22 (.27)	1.84 (.26)	1.74 (.26)
	NE	2.14 (.30)	1.94 (.08)	1.85 (.09)	1.17 (.46)	1.66 (.18)	2.31 (.31)	2.62 (.31)	2.36 (.30)	2.21 (.30)
Establishing a specific operational plan for incorporating ecosystem considerations into MAFMC/NEFMC decision making.	MA	2.00 (.24)	2.56 (.07)	2.01[a] (.08)	1.83 (.46)	2.20 (.29)	3.22 (.27)	3.06[a] (.27)	2.22 (.27)	1.83 (.27)
	NE	1.93 (.30)	2.41 (.08)	2.00 (.09)	2.17 (.46)	1.61 (.19)	3.00 (.31)	3.15 (.31)	2.23 (.31)	1.85 (.31)
Rewriting the MAFMC/NEFMC management requirements, under the Magnuson-Stevens Fishery Conservation and Management Act, to explicitly incorporate EBFM principles.	MA	2.71 (.25)	2.66 (.08)	2.24 (.09)	3.33 (.46)	1.92 (.31)	3.29 (.27)	3.06 (.27)	2.39 (.27)	1.78 (.27)
	NE	2.50 (.30)	2.38 (.09)	2.43 (.11)	2.50 (.46)	1.71 (.19)	3.23 (.31)	3.15 (.31)	2.50 (.30)	1.86 (.30)
Incorporating the EBFM approach into MAFMC/NEFMC priorities.	MA	2.05 (.25)	2.81 (.08)	2.25 (.09)	2.67 (.46)	1.86 (.30)	2.90 (.26)	2.50 (.27)	2.11 (.27)	1.50 (.27)
	NE	2.23 (.31)	2.68 (.09)	2.39 (.11)	2.17 (.46)	1.60 (.19)	3.00 (.31)	2.92 (.31)	2.46 (.31)	1.62 (.31)
Continuing inclusion of stakeholders on the MAFMC/NEFMC Advisory Panel for EBFM.	MA	2.00 (.24)	2.24 (.08)	2.27 (.09)	2.17 (.46)	1.86 (.30)	1.60 (.25)	1.68 (.26)	2.05 (.26)	1.84 (.26)
	NE	1.79 (.30)	2.19 (.08)	2.37 (.10)	1.83 (.46)	1.71 (.19)	1.86 (.30)	1.93 (.30)	2.23 (.31)	2.21 (.30)
Integrating social, economic, and community impact analyses into the MAFMC/NEFMC decision making processes.	MA	2.29 (.25)	2.04 (.07)	2.26 (.08)	2.83 (.46)	2.71 (.30)	1.45 (.25)	1.63 (.26)	2.00 (.26)	1.95 (.26)
	NE	2.29 (.30)	2.02 (.08)	2.23 (.09)	1.83 (.46)	1.94 (.19)	1.57 (.30)	1.93 (.30)	2.08 (.31)	2.43 (.30)
Transitioning from management based on quotas set per individual species to management based on quotas set for the total biomass of all fish species caught.	MA	2.44 (.27)	2.66 (.08)	2.49 (.08)	3.83 (.46)	3.00 (.34)	2.80 (.29)	2.73 (.29)	2.43 (.30)	2.19 (.28)
	NE	2.62 (.31)	2.46 (.09)	2.34 (.10)	2.67 (.46)	2.49 (.19)	2.00 (.32)	2.67 (.32)	2.46 (.34)	2.46 (.31)

Agreement was measured on a 5-point scale where 1=Extremely important, 2=Very important, 3=Moderately important, 4=Slightly important, and 5=Not important. Variable descriptions are identical to those printed in the survey.

[a] Statistically significant difference between groups with same letters within a row using a Bonferroni adjustment to the Two-Way ANOVA at $p \leq 0.05$.

There were some notable exceptions, in which Council members did not accurately predict stakeholder responses for fisheries management practices. For *Transitioning from management based on quotas set per individual species to management based on quotas set for the total biomass of all fish species caught*, MA Council members predicted MA SSC members would respond *Very important* whereas the MA SSC members actually responded *Slightly important* (*accuracy level*=2.60). For *Establishing a specific operational plan for incorporating ecosystem considerations into MAFMC/NEFMC decision-making*, MA Council members predicted MA recreational anglers would respond *Moderately important* whereas the MA recreational anglers actually responded *Very important* (*accuracy level*=2.95) and NE Council members predicted NE recreational anglers would respond *Moderately important* whereas the NE recreational anglers actually responded *Very important* (*accuracy level*=2.85). For *Identifying and prioritizing the key biological, physical, social, and economic factors that should drive decisions,* NE Council members predicted NE SSC members would respond *Very important* whereas the NE SSC members actually responded *Extremely important* (*accuracy level*=2.81) (Table 3). Decision maker and stakeholder survey responses show that governance is an important element of EBFM.

3.3.3. Management outcomes: agreement and accuracy

3.3.3.1. Agreement. *Agreement levels* were fairly high between both MA (Fig. 2e) and NE (Fig. 2f) Council member and stakeholder responses for the question: *How strongly would YOU support each one of the following options as a desired outcome for fisheries management in the MAFMC/NEFMC over the next 10 years?* Paired Council member and stakeholder mean responses to this question were generally at an *agreement level* of 3.0 or higher. Paired Council member and stakeholder mean responses included *Moderately support*, *Neutral*, and *Moderately oppose,* with the exception that MA SSC members responded *Strongly oppose* to *A complete, immediate change (0–4 years) from SSFM to EBFM*. Council members and stakeholders in both the MA and NE regions exhibited a somewhat wider range of support or opposition on questions related to management outcomes than on questions related to EBFM definitions and management practices.

Overall, the most supported management outcome option was *Incremental change from SSFM to EBFM*. This option was followed closely in support by: *An intermediate change from SSFM to EBFM* and *A complete, gradual (5-10 years) transition from SSFM to EBFM* (MA SSC members *Moderately opposed* this option but all NE stakeholders *Moderately supported* this option). The two least-preferred options were those on either end of the time spectrum: no change from current SSFM and complete immediate change (0-4 years) to EBFM. These results suggest that Council members and stakeholders do want to begin transitioning to EBFM, either partially or fully, but that they want the evolution to be slow (Table 4).

Agreement levels were less than 3 and contained different directional responses for several pairs. For *Continuation of single species fisheries management as currently practiced*, NE Council members responded *Moderately oppose* and NE commercial fishermen responded *Neutral* (*agreement level*=2.84); NE Council members responded *Moderately oppose* and NE recreational fishermen responded *Moderately support* (*agreement level*=2.41); and NE Council members responded *Moderately oppose* and NE SSC members responded *Neutral* (*agreement level*=2.74). For *A complete, gradual (5–10 years) transition from single species fisheries management to EBFM*, MA Council members responded *Moderately support* and MA SSC members responded *Moderately oppose* (*agreement level*=2.28). For *A complete, immediate change (0–4 years) from single species fisheries management to EBFM*, MA Council members responded *Moderately oppose* but MA SSC members responded *Strongly oppose* (*Agreement level*=2.83).

Table 4
Mean responses (with Standard Error) to the survey question "How strongly would YOU support each one of the following options as a desired outcome for fisheries management in the Mid-Atlantic/New England Fishery Management Council (MAFMC/NEFMC) over the next 10 years? " for Council members and stakeholder groups in the MA and NE regions.

Variable	Region	MEM	CF	RA	SSC	NGO	PRED_CF	PRED_RA	PRED_ SSC	PRED_NGO
Continuation of single species fisheries management	MA	3.19 (.26)	2.47 (.08)	2.36 (.09)	2.17 (.49)	3.79 (.32)	2.70 (.27)	2.78 (.28)	3.44 (.28)	4.47 (.29)
	NE	3.93[a] (.32)	2.77 (.09)	2.33[a] (.10)	2.67 (.49)	4.13 (.20)	3.29 (.32)	3.00 (.32)	3.50 (.32)	3.69 (.34)
Incremental change from single species fisheries management to ecosystem-based fisheries management (EBFM)	MA	1.81 (.26)	2.57 (.08)	2.10 (.09)	1.50 (.49)	2.43 (.32)	2.47 (.28)	2.17 (.28)	1.83 (.28)	2.11 (.28)
	NE	2.29 (.32)	2.28 (.09)	2.33 (.10)	1.50 (.49)	2.16 (.200)	2.54 (.34)	2.31 (.34)	2.29 (.32)	2.64 (.32)
An intermediate change from single species fisheries management to EBFM	MA	2.32 (.28)	2.69 (.08)	2.29 (.09)	3.17 (.49)	2.23 (.34)	3.18 (.29)	2.81 (.30)	2.56 (.300)	2.06 (.29)
	NE	1.92 (.34)	2.62 (.09)	2.40 (.10)	2.67 (.49)	2.17 (.20)	2.75 (.35)	2.50 (.35)	2.39 (.34)	2.62 (.34)
A complete, gradual (5–10 years) transition from single species fisheries management to EBFM	MA	1.95 (.27)	2.71 (.08)	2.22 (.09)	3.67 (.49)	2.57 (.32)	3.05 (.28)	2.56 (.28)	2.20 (.31)	1.65 (.29)
	NE	1.85 (.34)	2.37 (.09)	2.40 (.10)	2.17 (.49)	1.89 (.20)	2.85 (.34)	2.69 (.34)	2.08 (.35)	2.17 (.35)
A complete, immediate change (0–4 years) from single species fisheries management to EBFM	MA	3.67[a] (.26)	3.13[b] (.08)	2.55[a] (.09)	4.83 (.49)	2.86 (.32)	4.39[b] (.28)	3.65 (.29)	3.65 (.29)	2.65 (.29)
	NE	3.57 (.32)	2.84 (.09)	2.79 (.10)	4.17 (.49)	2.87 (.20)	4.08 (.34)	3.46 (.34)	3.15 (.34)	2.54 (.340)

Agreement was measured on a 5-point scale where 1=Strongly support, 2=Moderately support, 3=Neutral, 4=Moderately oppose, and 5=Strongly oppose. Variable descriptions are truncated versions of those printed in the survey.
[a, b]Statistically significant difference between groups with same letters within a row using a Bonferroni adjustment to the Two-Way ANOVA at $p \leq 0.05$.

3.3.3.2. Accuracy. Accuracy levels were relatively high for both the MA (Fig. 2e) and NE (Fig. 2f) Council member responses for the question: *How strongly do YOU think fishers, environmental non-governmental organization leaders, and Scientific and Statistical Committee members in the Mid-Atlantic/New England Region would support each one of the following options as a desired outcome for fisheries management in the Mid-Atlantic/New England Fishery Management Council (MAFMC/NEFMC) over the next 10 years?* Council members generally predicted stakeholder responses to the question with an *accuracy level* of 3.0 or higher, suggesting that Council members in both the MA and NE regions correctly predicted or closely predicted stakeholder responses regarding which options are desired outcomes for fisheries management in the MAFMC/NEFMC over the next 10 years.

Notably, pairs with *accuracy levels* less than 3 related to Council member predictions of responses from SSC members, commercial fishermen, and recreational fishermen. For *A complete, gradual (5–10 years) transition from single species fisheries management to EBFM,* MA Council members predicted that MA SSC members would respond *Moderately support* but MA SSC members actually responded *Moderately oppose* (*accuracy level*=2.53). For *A complete, immediate change (0–4 years) from single species fisheries management to EBFM*: MA Council members predicted that MA commercial fishermen would respond *Moderately oppose* but MA commercial fishermen actually responded *Neutral* (*accuracy level*=2.74); MA Council members predicted that MA recreational fishermen would respond *Moderately oppose* but MA recreational fishermen responded *Neutral* (*accuracy level*=2.90); MA Council members predicted that MA SSC members would respond *Moderately oppose* but MA SSC members responded *Strongly oppose* (*accuracy level*=2.81); NE Council members predicted that NE commercial fishermen would respond *Moderately oppose* but NE commercial fishermen actually responded *Neutral* (*accuracy level*=2.76); and NE Council members predicted that NE SSC members would respond *Neutral* but NE SSC members actually responded *Moderately oppose* (*accuracy level*=2.99).

The standard errors listed in Tables 2, 3 and 4, demonstrated that the SSC member response group has a larger intragroup range in viewpoint opinions than other stakeholder groups. This may reflect that within each Council, SSC members are selected to represent specific areas of expertise, so the SSC members on each Council should have knowledge in varying areas, leading to differing opinions.

4. Conclusion

The *Coorientation Model* was used as a framework for characterizing the degree of understanding between Council members and stakeholders [8]. The survey data showed relatively high agreement and accuracy between Council decision makers and stakeholders in both the MA and NE regions regarding concepts that should be included in the definition of EBFM, practices that should be implemented in fishery management plans, and implementation time lines, but suggested a wider spread in perceptions regarding some aspects of specific management outcome options. High agreement and high accuracy suggested that for both the MA and NE regions decision makers and stakeholders share common perceptions about many aspects of EBFM, and that understanding by decision makers of stakeholder perceptions is fairly robust, as decision makers usually correctly predicted or nearly correctly predicted stakeholder responses to many survey questions (Tables 2, 3, and 4). These findings demonstrate that Council members and stakeholders define EBFM as a holistic approach to management, support practices that are believed to be central to EBFM [18–20], and desire a gradual rather than rapid transition to EBFM.

The current system of SSFM fisheries management is deeply rooted in bureaucratic and institutional history including Council meeting proceedings, government scientist and Council staff responsibilities, data collection plans, legislative interpretation, public participation methods, monitoring and enforcement guidelines, and current management demands [1,2,21–23]. The study suggests that most Council members and stakeholders in the MA and NE regions want a change from SSFM to EBFM at an incremental, intermediate, or complete, gradual (5-10 years) pace, which may require acceptance of some uncertainty and a willingness to propose and implement a plan to transition to EBFM that is adaptable to evolving management needs. This study demonstrates that one of the greatest perceived needs for decision-maker and stakeholder adoption of EBFM in the MAFMC and NEFMC is more information about human dimensions, including economics, jobs, revenue, and communities.

Use of the *Coorientation Model* in the context of EBFM and the fishery management councils provides insights into how shared understanding of Council members and stakeholder groups could potentially facilitate the implementation of EBFM. The study highlights EBFM topic areas that are important to Council decision makers and stakeholder groups and about which communication, discussion, and combined action between Council decision makers and stakeholder groups could facilitate the adoption of EBFM in the MA and NE regions. The findings from this study suggest specific steps for the MAFMC and NEFMC moving forward with EBFM. Based on survey responses, tangible initial actions would include: developing a time line with defined outcomes; completing EBFM case studies in the Councils; and approving a regulatory mandate to provide direction and responsibility, which is partially reflected in NOAA's prioritization of EBFM [24]. The MAFMC and NEFMC agreed with the overall concept of EBFM but need specific, mandated, timed directives to more fully practice EBFM. Council members and stakeholders responded similarly to, and Council members correctly predicted stakeholder responses about, EBFM definitions, practices, and outcomes.

Neither low agreement between Council members and stakeholders nor low understanding of Council members regarding stakeholder perceptions of EBFM definitions or management practices appear to be barriers to MA or NE Council transition from SSFM to EBFM, although perceptions of specific EBFM management outcomes may differ somewhat among groups. Because Council members and stakeholders thought similarly about EBFM and Council members usually correctly predicted stakeholder perspectives, policy makers can minimize time educating managers and the public about each other's perspective and can instead focus on other barriers to EBFM implementation by the MAFMC and NEFMC. These findings suggest that Council member and stakeholder agreement and understanding are not barriers to MAFMC and NEFMC adoption of EBFM and allow managers to focus on other challenges to adoption of EBFM [25].

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